

Opinion

Schistosomiasis Control: Leave No Age Group Behind

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Despite accelerating progress towards schistosomiasis control in sub-Saharan Africa, several age groups have been eclipsed by current treatment and monitoring strategies that mainly focus on school-aged children. As schistosomiasis poses a threat to people of all ages, unfortunate gaps exist in current treatment coverage and associated monitoring efforts, preventing subsequent health benefits to preschool-aged children as well as certain adolescents and adults. Expanding access to younger ages through the forthcoming pediatric praziquantel formulation and improving treatment coverage in older ages is essential. This should occur alongside formal inclusion of these groups in large-scale monitoring and evaluation activities. Current omission of these age groups from treatment and monitoring exacerbates health inequities and has long-term consequences for sustainable schistosomiasis control.

Successes and Remaining Challenges in Sub-Saharan African Schistosomiasis Control

Schistosomiasis is a water-borne parasitic disease with over 220 million people infected in sub-tropical and tropical regions across the globe, the vast majority of whom live in sub-Saharan Africa [1]. For the last decade, the goal of the World Health Organization (WHO) has been to reduce schistosomiasis morbidity by this year (2020), and eliminate schistosomiasis as a public health burden by 2025 [2; Box 1]. The primary method for achieving these goals is **preventive chemotherapy (PC)** (see [Glossary](#)) through **mass drug administration (MDA)** with the anthelmintic praziquantel. These ambitious goals are underpinned by targets that require countries to reach at least 75% **treatment coverage** of **school-aged children (SAC)** and **at-risk adults**, with MDA schedules and target groups depending on schistosomiasis **endemicity** [3] ([Figure 1](#)). Data collated by WHO demonstrate that 46.3% of all people eligible and requiring treatment globally in 2017 were reached, while coverage of just SAC was higher at 70.8% [4]. Despite this progress, it is clear that access to praziquantel for SAC still falls short and **preschool-aged children (PSAC)**, certain adolescents, and adults are commonly omitted from MDA campaigns.

Models show that high PC coverage in both SAC and at-risk adults is required for morbidity control, particularly in high endemic areas [5,6]. Current programs do not always have complete **geographic coverage** across endemic schistosomiasis regions ([Figure 1B,C](#); [4,7]). Despite this, empirical work demonstrates that WHO goals can be achieved in as little as a single MDA round in low endemicity settings [8] but large-scale operational studies have also shown that persistent transmission hotspots are a common occurrence [9,10]. Although progress is being made, here we focus on highlighting the unique challenges to the control and management of schistosomiasis in age groups beyond SAC with a focus on PSAC and adults, but with implications for control of schistosomiasis across all ages.

Highlights

To date in sub-Saharan Africa, schistosomiasis treatment and monitoring focuses on school-aged children, but much less attention has been given to preschool-aged children and adults.

Here, we summarize the distribution and morbidity of schistosomiasis across these age groups and highlight gaps in current control strategies.

Preschool-aged children incur significant morbidity but are systematically excluded from current treatment programs; inclusion in control programs could have both short- and long-term health benefits.

Mass drug administration must be improved to reach at-risk adults. Low coverage has cascading implications for health, including morbidities specific to reproductive ages, and can facilitate infection with other diseases such as HIV.

Control and elimination of schistosomiasis will require future integration of all age groups into treatment programs and evaluation of progress.

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Box 1. Neglected Tropical Disease (NTD) Roadmaps

NTDs are a diverse group of infections that impact the world's poorest communities. The WHO first convened Global Partner Meetings in 2007 to help integrate strategies, goals, and targets across disease-control programmes. The roadmap includes specific targets for each of the twenty NTDs. For schistosomiasis, the goal is to control the disease by 2020 (defined as <5% heavy infection intensities across sites) and eliminate the disease as a public health problem by 2025 (defined as <1% heavy infection intensity across sites). To achieve these goals, the WHO originally set a target of 75% treatment coverage of SAC. A draft of the NTD Roadmap for 2021–2030 has just been published by the WHO and partners for further consultations [12]. In the new roadmap, 'extending PC to all populations in need and ensuring access to the necessary medicines' is critical action for schistosomiasis alongside more integrated control methods. These actions will be necessary for achieving the ambitious goal of eliminating schistosomiasis as a public health problem (defined as <1% proportion of heavy intensity infections) in all endemic countries by 2030). In this opinion article we argue that PSAC, adolescents, pregnant women, and adults across many communities urgently require treatment to reduce individual morbidity and improve PC efficacy.

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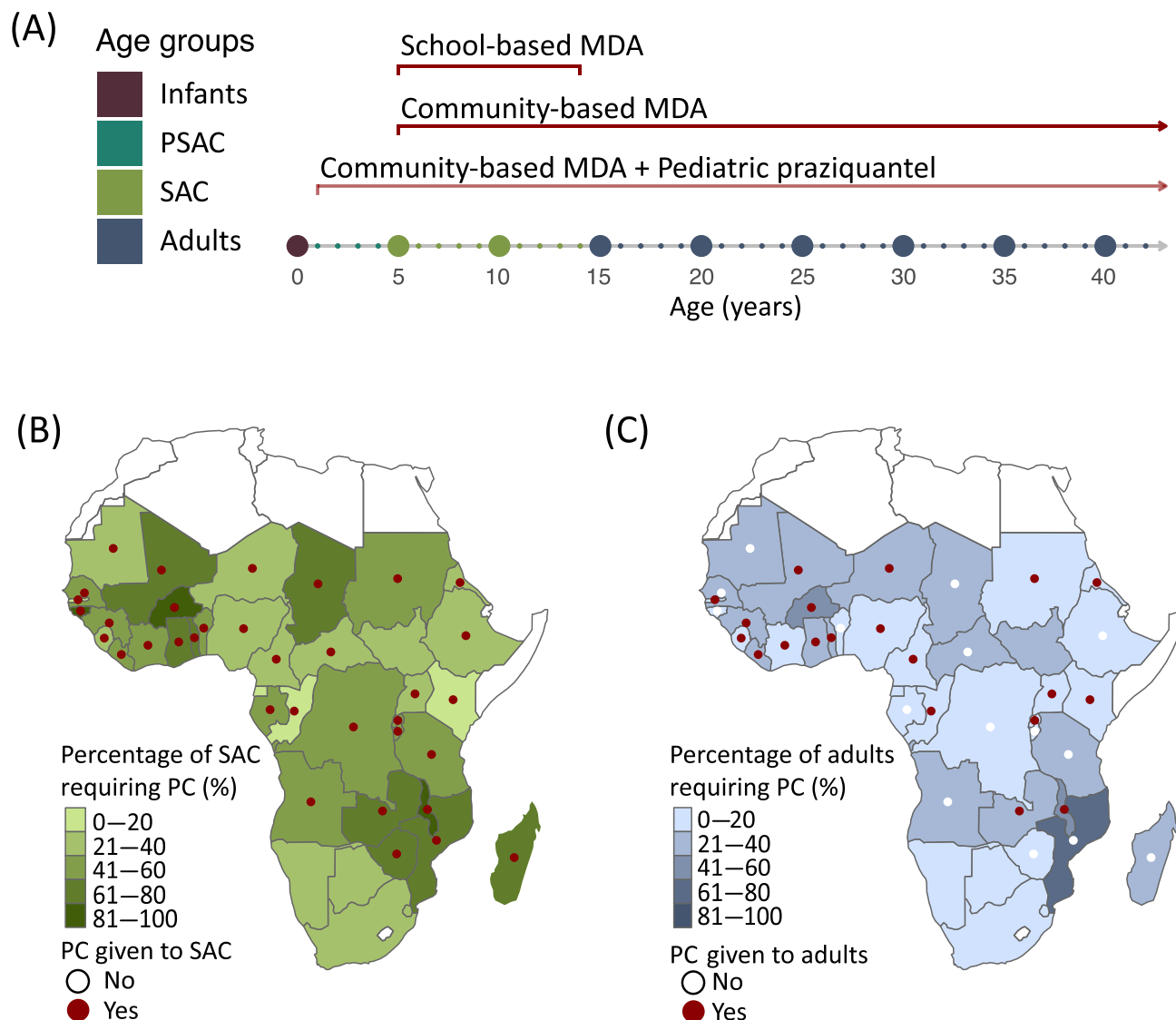
Currently, schistosomiasis control in endemic regions relies on regular MDA and monitoring of infections in SAC (Figure 1A,B). Overemphasis of treatment and evaluation in this limited age group eclipses other high-risk groups and may lead to bounce backs later on [11]. As we enter the new decade, the WHO and partners have put forward a draft of an updated Neglected Tropical Disease (NTD) roadmap for 2021–2030 [12] which includes new goals for schistosomiasis control and elimination as a public health problem (Box 1). Despite heightened control efforts over the past decade, the roadmap indicates that critical action is required for expanding PC to all populations at risk. In order to succeed across wide geographic areas, we argue that both control and monitoring strategies should extend to all age groups such that no one with schistosomiasis is systematically excluded. Here, we provide an evaluation of the epidemiological and clinical manifestations of schistosomiasis in age groups beyond SAC, discuss their current inclusion in control strategies, and highlight consequences of existing policies on **health inequities**.

Epidemiology of Schistosomiasis and Age Structures in the Era of MDA

Prevalence of schistosomiasis among SAC is used to establish endemicity and inform control strategies [3]. This was initially justified by a series of studies that demonstrated that schistosomiasis in SAC, particularly in children 9–12 years of age, positively correlated with the prevalence and intensity across communities in a diversity of geographical and epidemiological settings [13]. However, many of these studies were conducted before national MDA programs began, and as the burden across a community is unevenly altered by ongoing control interventions a reappraisal of individuals at risk, those requiring treatment, and those contributing to transmission is needed.

The **age structure**, or relative abundance of individuals in each age class, varies between countries and is dependent on birth and death rates. In many of the sub-Saharan African countries which are highly endemic for schistosomiasis, high birth rates mean that PSAC, 1–4 years old, can comprise up to 25% of the population ([14]; Figure 2A,B). Even in these rapidly growing populations, adults are still the most abundant age group. Age prevalence and intensity curves vary across endemicity areas, and are also likely altered by treatment history, particularly where that treatment has repeatedly targeted only an age-specific subsection of the population.

Community members that aren't covered in school-based MDA, including **infants**, PSAC, nonenrolled school-aged children, and/or adults, could be important contributors to schistosome transmission [15,16] (Figure 2C,D). Of the approximately 120 million children affected by schistosomiasis worldwide, it is estimated that approximately 50 million are PSAC [17–19]. Children below 5 years of age are not regularly included in MDA campaigns [20], and drug licensing of praziquantel only applies to individuals aged 4 years and above. In addition, certain adolescents and adults, particularly those aged 16–25 years, can have mean infection intensities that are higher than those of SAC [21–23], most commonly when their livelihoods put them in daily



Trends in Parasitology

Figure 1. Age Transitions across Lifetime and Treatment Interventions for Individuals in Schistosome Endemic Regions in sub-Saharan Africa. (A) Infants (<1 year) and preschool-aged children (PSAC) (1–4 years) are currently not included in any mass drug administration (MDA). At-risk adults (>14 years) are included in MDA only if the prevalence in school-aged children (SAC) is >50% (see endemicity in the [Glossary](#)). (B) Estimates of the percentage of SAC (here shown as 5–14 years) in sub-Saharan African countries requiring schistosomiasis preventive chemotherapy (PC) (data from [\[7,14\]](#)). Red points indicate countries that gave PC to SAC in 2017 and/or 2018, the most recent reporting years. (C) Estimates of the percentage of adults (here shown as 15 years and older) in sub-Saharan African countries requiring schistosomiasis preventive chemotherapy. Red points indicate countries that gave PC to adults in 2017 and/or 2018, and white indicates no PC for adults. The absence of points and shading indicate data not available (or outside sub-Saharan Africa).

contact with infectious water (e.g., car washing, fishing, housework in regions with limited access to clean water) [\[24,25\]](#). A recent systematic review of studies on MDA found that **combined MDA (community-based MDA supplemented with school-based MDA)** had the highest overall coverage in SAC, including unenrolled SAC, better than school-based MDA which had the lowest overall coverage in SAC [\[26\]](#). Because MDAs are targeted at a subset of the population, this selective treatment can cause an age shift in prevalence and **intensity of infection**, meaning that the burden of schistosomiasis accumulates at older ages with increasing school-

based MDA or higher coverage in SAC during community-based MDA [5], though the effect at larger scales still needs to be investigated. Regardless, theoretical work has underscored the importance of quantifying infections across all community members to design the most effective control and monitoring programs for schistosomiasis [6].

PSAC Are Still Excluded from MDAs

Despite recommendations by the WHO in 2010 to treat 2- and 3-year-old PSAC with praziquantel in off-licence settings [17], guidelines are difficult to implement. Praziquantel is only formally licensed for 4-year-olds and above, and the global community continues to discuss the best tools and approaches for targeting this age group. Reasons for PSAC exclusion from MDA are wide ranging and include operational difficulties in access and diagnosis, inadequate knowledge about risk and infection burden, and lack of a pediatric formulation of the drug praziquantel for treatment of this age group [27] (Box 2).

We now know that schistosome infection can occur with water contact immediately after birth [20,28–30], and that the intensity of infection continues to accumulate until a child's first praziquantel treatment at age 5 years or older during MDA. This age group can have prevalence rates exceeding 50%, and intensities of over 400 eggs per gram (epg) of stool have been detected in children as young as 2 years [31,32]. Such heavy infections in PSAC reduce physical and cognitive development and, when persistently untreated, can lead to severe morbidity, and in serious cases, mortality [33]. Given the opportunity to influence overall future health in infants and young children, repeated treatment in these groups could provide lasting health benefits [34]. Praziquantel treatment has been shown to significantly reduce schistosome-associated proteinuria, albuminuria, and microhaematuria in PSAC [34]. Children 5 years of age and below can develop microhaematuria as soon as 3 months after exposure, and existing tools are suitable for diagnosis [35]. Promisingly, this early morbidity resolves within 3 months of a single dose of praziquantel treatment [35]. More chronic effects on growth and development, for example stunting, may be irreversible if infection is left untreated for longer periods. To help mitigate this, experimental modelling suggests that repetitive treatment before reaching school age (~6 years of age) can facilitate 'catch-up growth' [36]. However, current exclusion of this age group from MDA programs creates a serious health inequity, particularly in high-endemicity areas [27,37,38]. By leaving this age group untreated, PSAC are systematically excluded from the benefits of treatment, leading to accumulation of morbidity that can become irreversible, an unacceptable health deficit unparalleled in any other parasitic disease.

A well known deficit of praziquantel is that treatment does not prevent reinfection(s), which upon subsequent water contact and exposure leads to recurring infection and progressive morbidity [39,40]. However, treatment of schistosome infections can induce protective immune responses against reinfection [41–43], and an increase in post-praziquantel immune responses are associated with reduced reinfection levels in PSAC [44]. In addition, evidence from experimental studies suggests that treating short duration infections provides greater levels of protection against reinfection compared with immunity developed through treatment of longer, more chronic infections [45,46]. Therefore, early treatment of schistosome infections in PSAC can be further justified to reduce reinfections and associated long-term morbidity.

Opportunities for Interventions in PSAC

If we are to deliver sustainable schistosomiasis elimination programs, treatment of PSAC needs to be prioritized. There are major unanswered questions: how do we quantify infection in this age group, and more importantly, unlike SAC, who typically are easily reached through school-based programs, how do we access these younger children and at what frequency [17,47]? A

Glossary

Age structure: the age structure of a country is defined by the proportion of the population in different age classes. The age structure of a country's population is determined by mean birth and death rates at each age.

At-risk adults: adults that are frequently exposed to unsafe water. This can range from a subset of a community that engages in economic and domestic activities that put them in contact with water to all adults in a community living close to an infested water body. We use 'at-risk adults' and 'adults' interchangeably in this piece.

Endemicity: categories of schistosomiasis risk determined at the community or regional level. The WHO gives guidelines for three categories of risk and the MDA schedules for each, which is based on the prevalence in school-aged children determined by parasitological methods:

- Low endemicity: <10%. Recommend treating all school-aged children twice during primary school and having praziquantel available at dispensaries and clinics.
- Moderate endemicity: >10% but <50%. Recommend treating school-age children and adults at risk once every 2 years.
- High endemicity: > 50%. Recommend treating school-age children and all adults at risk once a year.

Geographic coverage: the proportion of endemic country implementation units (usually districts or states) that are reached in a given round of MDA.

Health inequity: a systematic difference in health based on demographics or social status (such as age group).

Infants: usually defined as children under 1 year of age. Not the focus of this paper as there are currently limited schistosomiasis treatment options, even in the pipeline, for this age category.

Intensity of infection: the infection intensity of schistosome infections is indirectly measured by counting the number of eggs excreted in feces (expressed as eggs per gram, epg) or in urine (expressed as eggs per 10 ml of urine), depending on the species. Infection intensity of intestinal schistosomiasis is defined as light intensity (0–99 epg), moderate intensity (100–399 epg) or heavy intensity (>400 epg). Infection intensity of urogenital schistosomiasis is defined as light

'test and treat' approach for PSAC [17,48] – pending roll-out of the pediatric praziquantel formulation – could significantly reduce infection and disease burden in this age group. If PSAC treatment falls within MDA, it will be important to estimate the infection burden in PSAC to identify focal areas where treatment is needed most [48]. The frequency of treatment could follow guidelines set by the WHO, but whether or not endemicity of an area (determined by SAC prevalence [19]) is an accurate estimate of PSAC burden is not fully understood and requires more research.

Studies in some endemic areas have shown that existing health systems can be tapped to improve access to PSAC and nonenrolled SAC at primary and/or secondary school levels. For example, studies in Zimbabwe have utilized the local primary health centers as a means to access PSAC, showing high compliance even in follow-up studies [35,39,49]. In other countries, Child Health Days offer a potential opportunity for easily reaching PSAC [17], as demonstrated in Uganda for albendazole treatments [50]. Another approach is to empower health workers to identify and treat nonspecific signs of suspected clinical cases of schistosomiasis in PSAC [48]. The caveat here, however, will be the potential of providing praziquantel treatment for nonspecific clinical symptoms due to other conditions aside from schistosomiasis. Of critical importance will be to monitor and evaluate any changes and constraints that these strategies may cause to health systems already implementing other intervention programs. PSAC are currently not included in national or regional metrics on schistosomiasis, and they should be included in formal monitoring and evaluation across a diversity of endemicities to address this critical gap in knowledge.

Improvements in Treatment Uptake among Adults Is Urgently Needed to Combat Chronic Schistosomiasis

By contrast to PSAC, at-risk adults in high endemicity areas are currently eligible to receive treatment annually during community-based MDA, but coverage of adults is significantly lower than that of SAC [4]. A minority (43.8%) of the population eligible for schistosomiasis PC in sub-Saharan Africa (does not include PSAC) were successfully treated in 2017, similar to global levels described in the introduction – the majority were SAC (coverage 69.4%); only 13.4% of adults requiring PC were treated [4]. Adults are not included in several national control programs despite a high proportion of adults requiring PC across the region (Figure 1C). Notwithstanding insufficient stocks of praziquantel, barriers to adult uptake of MDA include community perceptions of schistosomiasis as a children's disease, hesitancy to report symptoms of schistosomiasis due to fear of stigma, failure to offer drugs to adults during MDA, nonspecific or mild symptoms, fear of side effects, and difficulty seeking MDA if it requires time away from work [51–55]. Pregnant women are frequently excluded from MDA, despite studies demonstrating the safety and efficacy of praziquantel during pregnancy and lactation [56,57]. Many health practitioners and national policy makers are reticent to support treatment of pregnant women [58]. With an average of 4.5 live births per female across sub-Saharan Africa [14], a significant portion of the crucial years of a female's adult life can be spent excluded from MDA. These gaps in treatment coverage, especially if individuals are systemically untreated, have significant clinical impacts, as discussed below, and can play a major role in maintaining transmission even after decades of MDA [59,60]. Monitoring efforts to measure treatment uptake, concurrent with parasitological surveys to measure prevalence and intensity, are necessary to improve effectiveness of current community-based MDA. Additionally, we believe it is time for a re-evaluation of current MDA guidelines to ensure that adolescents and adults who are infected across a range of endemicities are eligible to receive treatment.

Morbidity in Adults

Female genital schistosomiasis (FGS) and male genital schistosomiasis (MGS) are gender-specific manifestations of schistosomiasis associated with pathology caused by the migration of

intensity (1–50 eggs per 10 ml) or heavy intensity (>50 eggs per 10 ml).

Mass drug administration (MDA):

the administration of treatment (praziquantel for schistosomiasis) to every member of a defined population, irrespective of individual infection status.

- **School-based MDA:** praziquantel (for schistosomiasis) only distributed at schools (usually primary schools, but sometimes also secondary schools).

- **Community-based MDA:**

praziquantel (for schistosomiasis) distributed to community members deemed to be at risk – usually all school-aged children (SAC) and at-risk adults. Recommended door-to-door administration but can also be, and usually is, distributed centrally.

- **Combined MDA:** praziquantel (for schistosomiasis) distributed to community members deemed to be at risk and at schools.

Preschool-aged children (PSAC):

individuals that are here defined as children between 1 and 4 years of age, but the specific range can vary by location (sometimes 1–5 years old). We include toddlers (1–2 years of age) in PSAC as these ages are included in the pediatric praziquantel formulation (Box 2).

Preventive chemotherapy (PC): the use of safe, effective drugs to treat populations at risk to prevent morbidity.

School-aged children (SAC):

individuals that are usually defined as children between 5 and 14 years of age, but the specific range can vary by location. These children are usually eligible to attend primary school. However, all children in this age range – both enrolled and unenrolled in school – are part of this group regardless of their school enrolment or attendance. Nonenrolled SAC are also often neglected in school-based MDA campaigns.

Treatment coverage: the proportion of eligible individuals (above the age of 5 years and/or SAC based on MDA guidelines) that take praziquantel in a given round of MDA.

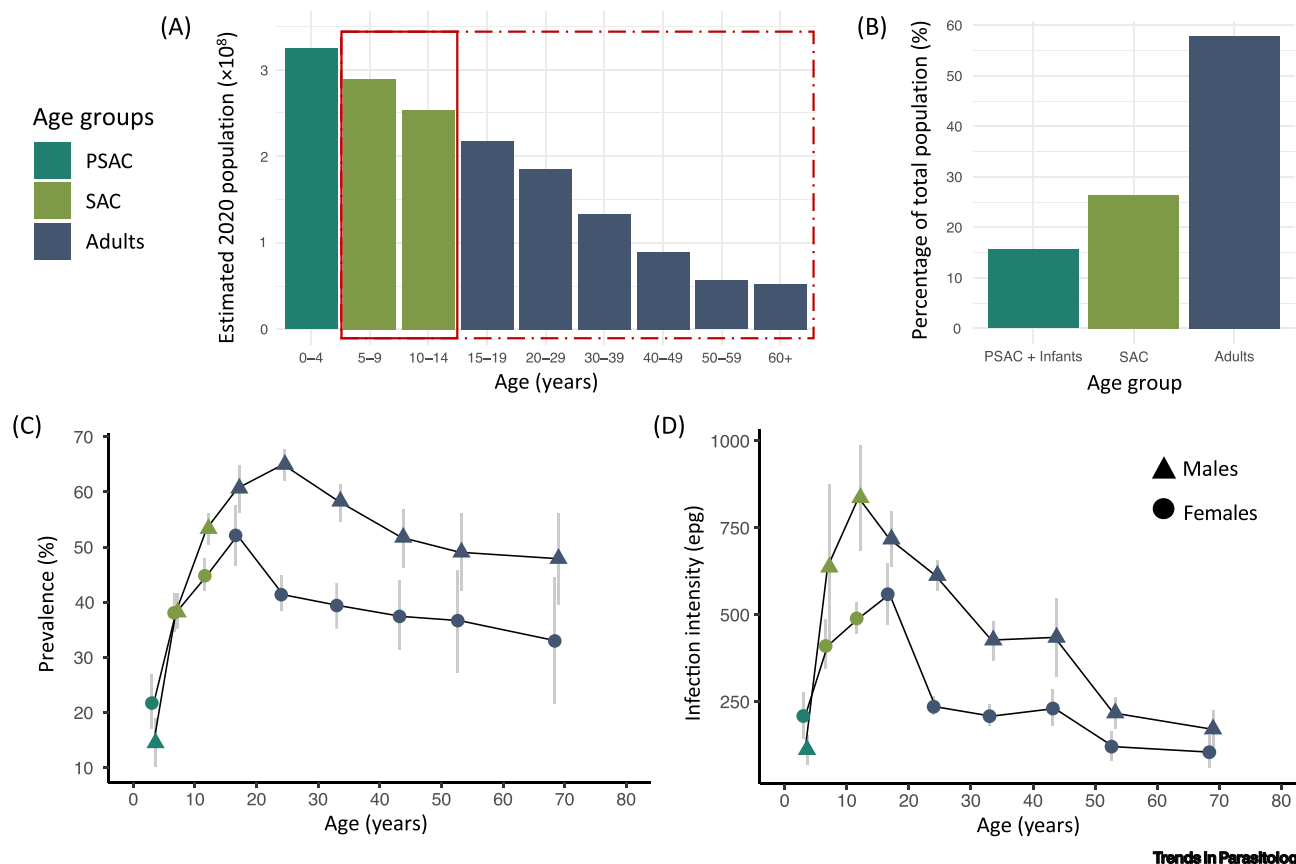


Figure 2. Distribution of Populations and Schistosomiasis Burden across Age Groups in sub-Saharan Africa. (A) Growing populations in sub-Saharan Africa mean that the population, on average, is very young [14]; the solid red rectangle indicates individuals eligible for school-based mass drug administration (MDA), whereas the dot-dash rectangle indicates those currently included in community-based MDA. (B) The majority of the population are in the adult age group (ages 15 and above). (C) Prevalence of *Schistosoma mansoni* across major age groups in a survey of ~10 000 individuals in Uganda (data from [15]). Peak prevalence in females occurs between 15 and 19 years, whereas males' peak prevalence occurs from 20 to 29 years, and then falls in both sexes as they grow older. (D) *Schistosoma mansoni* infection intensities from the same population, showing that infection intensities peak at approximately the same age (or even older for females) and then decline more rapidly than prevalence. Abbreviations: epg, eggs per gram; PSAC, preschool-aged children; SAC, school-aged children.

schistosome eggs through genital tissue. While most commonly observed with *Schistosoma haematobium* infection, cases associated with *Schistosoma mansoni* infection have also been described [61,62].

In approximately half of the girls and women with *S. haematobium* infection, or an estimated 40 million girls and women in Africa [63], FGS causes gynecological morbidity marked by symptoms including postcoital bleeding, genital itch, genital discharge, and infertility. The infection additionally has been

Box 2. Pediatric Praziquantel Consortium

Praziquantel is an existing drug approved for treatment of schistosomiasis and is currently licensed for ages 4 years and older, although off-label informal use for younger children with infections is advised by WHO. To improve formal access to treatment, the Consortium's goal is to make an orally dispersible tablet (ODT) of praziquantel that is suitable for use and dosing in children aged from 3 months to 6 years. Phase I and II clinical trials are complete, and the Phase III trials of safety and efficacy of the developed monoisomeric praziquantel formulation in ODT (150 mg) for subsequent dosing at 50 mg/kg are ongoing. The trials are comparing the new ODT with crushed or broken praziquantel tablets in the target age group. Pending success in these trials, which will allow formal change in licensing of praziquantel, this pediatric praziquantel formulation will help to alleviate the current health inequity in schistosomiasis control.

associated with stigma and often goes untreated due to misperceptions of FGS as a sexually transmitted infection and lack of awareness of healthcare workers about this debilitating condition [54]. Even when FGS is suspected, confirmatory laboratory testing is limited by poor sensitivity [64]. Another broken connection is the interplay of FGS and menstrual hygiene management [65]. In addition to direct gynecological effects, FGS has also been associated with increased prevalence of HIV infection [66,67] and *S. haematobium* infection with increased hazard of HIV acquisition in women [68]. Evidence suggests that early, repeated praziquantel treatment in girls may have the potential to reverse these gynecological abnormalities [69] and potentially to decrease the risk of HIV acquisition in at-risk girls and women.

MGS was first described in 1911 by Madden in Egypt [70]. It has been found in 43% of participants in a small epidemiological study [71] and up to 58% of autopsy patients infected with *S. haematobium* [72], but the majority of published research on MGS is case studies [73]. MGS causes genital or ejaculatory pain, abnormal ejaculate content, haemospermia, infertility, enlarged genital organs, granulomatous infiltration, fibrosis, and calcifications [62,71,74,75]. Though praziquantel resolves some of the symptoms, the reversibility of chronic pathologies is not yet known, and more frequent doses may be more efficacious [76]. The distribution and full extent of MGS is unknown as there are challenges in the diagnosis – semen microscopy, in particular, has low sensitivity and is difficult to carry out in standard healthcare practice [77]. Other prevalent co-occurring diseases, such as sexually transmitted infections and tuberculosis, present symptomatology and pathologies similar to those of MGS, further complicating diagnosis. While early studies suggested a relationship between MGS and HIV, more research is required to understand the role of MGS in HIV acquisition and onward transmission [68,78–81].

For both MGS and FGS, awareness of these conditions, improved diagnosis, and timely treatment are needed to alleviate the clinical burden of chronic infections and to address comorbidities that they facilitate. Further operational and implementation research studies on FGS and MGS are critically needed in order to address these neglected forms of schistosomiasis and understand how improved uptake and frequency of treatment can prevent and reverse morbidity. Regular inclusion of adults in monitoring activities will improve understanding of the scope and distribution of schistosomiasis in communities and help to target gender-specific interventions.

Opportunities for Strengthening Interventions in Adults

Numerous opportunities exist to improve access of MDA to adults [82], and local data documenting the most significant barriers may be useful in designing the most effective strategies for improvement in specific communities or regions. Some interventions likely to be successful in many sites include optimizing selection and training for community drug distributors [83], providing health education about schistosomiasis [84] focusing on adults who have lived in villages for prolonged periods [85], and targeting young adults in college or other youth settings [51,86]. Repeated MDA campaigns can lead to treatment fatigue [85], and low compliance may be low due to nonspecific symptoms. Therefore, targeted treatment, including ‘test and treat’, may be a useful tool in encouraging drug uptake in communities and has been used successfully in low-endemic settings [87]. Ensuring reliable availability of praziquantel in health centers will also facilitate access to treatment outside of the often-narrow time window of MDA.

Reinfection still occurs even after treatment in adults. Even successfully delivered annual praziquantel treatment may be insufficient; 40% of adult women in an endemic region who had schistosome infections treated at baseline were found to be schistosome-infected at least once during 12 months of follow-up [55]. These findings are supported by other studies in communities with high water contact in adults [24,25], although reinfection occurs more often in SAC

and younger groups [10], potentially due to an increase in adult immunity towards reinfection. Although treatment will not completely prevent morbidity due to reinfection, community-based MDA is more cost-effective than school-based MDA in a range of settings [88,89] and there is a reduced likelihood of reinfection in adults [25].

Treatment as a Complement to Integrated Methods for Interventions

Identifying communities with a persisting high prevalence of infection, determining the best approaches to deliver drugs outside of the school environment, building capacity within health centers, ensuring sufficient praziquantel availability, and targeted approaches to undertreated age groups are all ways to improve existing MDA programs [26]. However, treatment with praziquantel will not be sufficient for the sustainable control and elimination of schistosomiasis in many areas [90]. Improved water, sanitation, and hygiene (WASH), behavior change, targeted education, and snail control are all fundamental facets to ensuring that schistosome transmission will reduce, and be ultimately eliminated, in endemic communities [91] and are cost-effective [92]. It is important that these additional interventions be deployed equitably so that benefits are achieved throughout the lifespan of individuals. Precision mapping provides an innovative way to better target interventions and allocate resources to focal transmission areas and the specific species of *Schistosoma* to target [93]. Strengthening deployment while reducing the global burden of disease will improve the financial sustainability of control programs.

Concluding Remarks

At any age, coming into contact with fresh water harboring cercariae can lead to schistosome infection. Indeed, schistosomiasis can be pervasive, and it affects the world's poor, who are commonly dependent on local water bodies and at risk for exposure, sometimes on a daily basis. Whilst water contact patterns and immune status may change throughout life, there is an urgent need to ensure that treatment is available to all age groups (see [Outstanding Questions](#)). MDA with praziquantel, which is inexpensive and has a low side-effect profile, has focused primarily on SAC but, as we strive for elimination, it is clear that widening this approach to include the entire population at risk will be essential for success, and we should leave no one behind.

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Outstanding Questions

What are the most effective methods to improve access to information and treatment in groups already eligible for MDA, including pregnant women and unenrolled SAC?

How can infected individuals receive treatment outside of MDA programs?

Can we identify characteristics of communities where it is essential to integrate control in PSAC and adult age groups?

Can we include monitoring of all age groups in schistosomiasis programming so that PSAC and adults are systematically included in the evaluation of control effectiveness and used to inform future control strategies?

Pending roll-out of the pediatric formulation of the anthelmintic praziquantel, what is the best way to quantify infection burden in PSAC to inform control strategies? How can we leverage existing health systems to improve treatment access to this age group?

What mechanisms cause FGS and MGS, and what interventions can prevent these conditions?

If treatment is expanded to include all age groups at risk, will there be sufficient praziquantel available? And if not, how can we produce and access the higher numbers of praziquantel tablets needed for this wider treatment campaign?

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